

**LUBRICATING OIL SUPPLY SYSTEM FOR THE CONNECTING ROD
BEARINGS OF A CRANKSHAFT OF A MULTI-CYLINDER INTERNAL-
COMBUSTION ENGINE**

BACKGROUND AND SUMMARY OF THE INVENTION

[0001] This application is a continuation of PCT Application No. PCT/EP02/00604 filed January 23, 2002, which claims priority to German Patent Application No. 101 05 542.0 filed on February 7, 2001.

[0002] The invention is based on a lubricating oil supply system for the connecting rod bearings of a crankshaft of a multi-cylinder internal-combustion engine, in which oil ducts extend from bearing journal to crank pins of the crankshaft, oil supply taking place by way of main bearings of the crankshaft in that the oil ducts extend from one main bearing or bearing journal respectively to the crank pins or connecting rod bearings in each case adjoining on both sides.

[0003] German Patent Document DE 696 05 567 T2 illustrates a crankshaft for a 4-cylinder in-line engine in the case of which, by way of the bearing journals or main bearings of the crankshaft, the lubricating oil supply to the crank pins or connecting rod bearings adjoining the main bearing on both sides takes place by way of oil bores made in the crankshaft. As a result of supplying lubricating oil to two connecting rod bearings respectively by way of a crankshaft main bearing, the central main bearing can remain free of oil supply bores or oil supply grooves.

[0004] It is also known (see, for example, French Patent Document FR-PS 979 586) to provide partial oil supply grooves in the main bearing shells of the crankshaft, which partial oil supply grooves are arranged in a deviated manner with respect to the gas force plane. By way of two oil bores provided in the bearing journal of the crankshaft, a permanent lubricating oil supply to the connecting rod bearing can in this case be ensured by way of the partial oil supply grooves. Simultaneously, the bearing fraction of the main bearing can be maintained in the direction of the gas force plane.

[0005] It is an object of the invention to provide a lubricating oil supply system for the connecting rod bearings of a crankshaft of a multi-cylinder internal-combustion engine, in the case of which, on the one hand, a secure and reliable lubricating oil supply to the connecting rod bearings of the crankshaft is ensured and, on the other hand, the main bearings of the crankshaft, which are more stressed particularly in the high rotational speed range, can securely absorb the gas forces and inertia forces.

[0006] This object is achieved by providing lubricating oil supply system for the connecting rod bearings of a crankshaft of a multi-cylinder internal-combustion engine, in which oil ducts extend from bearing journals to crank pins of the crankshaft, oil supply taking place by way of main bearings of the crankshaft in that the oil ducts extend from one main bearing or bearing journal respectively to the crank pins or connecting rod bearings in each case adjoining on both sides, wherein, in respective bearing journals of the crankshaft for the lubricating oil supply to the connecting rod bearings adjoining on the left and right respectively, two oil bores respectively are provided which extend at an angle and, converging to a third oil bore, extend to two adjoining crank pins, and wherein the two oil bores interact with oil supply grooves provided in the main bearings for the lubricating oil supply.

[0007] Particularly in the case of a 6-cylinder opposed-cylinder engine with a 120° spark gap, it was found that, starting at a certain rotational speed level, the bearing forces acting upon the main bearings in the case of which the oscillating inertia forces transmitted on the left and on the right by the crank pins are not compensated will clearly rise while the bearing forces in the case of the main bearings whose adjoining pair of crank pins is mutually offset by a crank angle of 180° remain essentially constant independently of the rotational speed because of the compensation of the oscillating inertia forces. The suggested lubricating oil supply concept for the connecting rod bearings takes this circumstance into account. Simultaneously, the same width can be maintained for all main bearings despite different bearing loads.

[0008] In order to be able to maintain the bearing fraction of the main bearings responsible for the lubricating oil supply, it is suggested to provide these main bearings only with partial oil supply grooves which interact with two oil bores respectively provided in the bearing journal, so that, alternatingly by way of one oil bore respectively, a continuous lubricating oil supply to the connecting rod bearings is ensured. In this case, the oil supply grooves are arranged to deviate by approximately 90° with respect to the gas force plane so that the bearing fraction of the main bearings in the direction of the applied main forces is not reduced.

[0009] The following description and the claims contain additional advantageous further developments and improvements of the lubricating oil supply system for the connecting rod bearings of a crankshaft.

[0010] Other objects, advantages and novel features of the present invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Figure 1 is a view of a crankshaft of a multi-cylinder internal-combustion engine constructed according to preferred embodiment of the present invention;

[0012] Figure 2 is a sectional view along Line II-II in Figure 1; and

[0013] Figure 3 is a schematic representation of the lubricating oil supply system in the area of a main bearing of the arrangement of Figure 1.

DETAILED DESCRIPTION OF THE DRAWINGS

[0014] The crankshaft of a 6-cylinder opposed-cylinder engine illustrated in Figure 1 has seven bearing journals 1 to 7 which are accommodated in main bearing shells HL I - HL VII. In this case, as generally known, the main bearing shells HL I - HL VII are received in corresponding bearing blocks of the

crankcase (not shown) of the internal-combustion engine. The crankshaft has six throws, in which case, the big ends of the connecting rods, which are not shown, are rotatably fastened to the crank pins 8 to 13. As customary in the case of a 6-cylinder opposed-cylinder engine with a 120° spark gap, the crank pins 8, 9 and 10, 11 and 12, 13 respectively adjoining the bearing journals 2, 4, 6 are in each case arranged to be mutually offset by a 180° crank angle, while these crank pairs, in turn, are in each case arranged to be mutually offset by a crank angle of 120°.

[0015] Two bores 14 and 16 respectively extending at an angle of 90° with respect to one another are arranged in the bearing journals 2, 4, 6, which bores 14 and 16, converge to form an oil bore 18 which extends to the two respective adjoining crank pins 8, 9 and 10, 11 and 12, 13 respectively.

[0016] The main bearing shells HL II, HL IV and HL VI have two partial oil supply grooves 20 and 22 which, as illustrated in Figure 3, extend along a circular-arc angle of 100° respectively. On the exterior side of the main bearing shells HL II, HL IV and HL VI, four exterior grooves 24 respectively are arranged, only two of which being shown here, and which are connected by way of a bore with the partial oil supply grooves 20 and 22 situated on the inside.

[0017] In the installed condition of the crankshaft in the crankcase of the opposed-cylinder engine, the oil supply grooves 20 and 22 in the main bearing shells HL II, HL IV and HL VI are in each case made such that they extend offset by 90° with respect to the gas force plane over an angle of approximately 100°.

[0018] The lubricating oil supply to the connecting rod bearings fastened to the crank pins 8 to 13 takes place as follows:

[0019] By way of a lubricating oil supply pump, which is not shown, the main bearings HL II, HL IV and HL VI are supplied with lubricating oil by way of oil bores arranged in the crankcase. For this purpose, the lubricating oil, by way of

the oil grooves 24 arranged on the outside at the main bearing shells HL II, HL IV and HL VI arrives in the partial oil supply grooves 20 and 22 provided on the interior side of the main bearing shells, the lubricating oil, in an alternating manner, arriving at the crank pins 8, 9 and 10, 11 and 12, 13 respectively by way of the oil bore 14 or 16 and by way of the oil bore 18. The lubricating oil emerging at the surface of the crank pins 8, 9 and 10, 11 and 12, 13 respectively is used for lubricating the connecting rod bearings rotatably fastened on the crank pins. As a result of the fact that the partial oil supply grooves 20 and 22 extend along an angular range of 100° and that the two bores 14 and 16 are arranged at an angle of 90° , it is ensured that a permanent lubricating oil supply to the crank pins takes place at least by way of one of the two bores 14 or 16. On the other hand, the vectorially adding-up gas and inertia forces acting in the direction of the cylinder axis are reliably absorbed by the main bearing shell segments not provided with the oil supply groove, which segments are not reduced in their bearing width with respect to the main bearing journals 1, 3, 5 and 7.

[0020] While the bearing stresses in the main bearings HL II, HL IV and HL VI caused as a result of the oscillating inertia forces remain almost constant independent of the rotational engine speed, particularly the bearing forces acting upon the main bearings HL III and HL V rise because of the non-existing balancing of masses proportionally to the rotational speed of the engine. As a result of the above-described system, on the one hand, a reliable lubricating oil supply to the connecting rod bearings is ensured. On the other hand, while maintaining a uniform bearing width for the crankshaft, the internal bearing forces acting upon the main bearings HL III and HL V are reliably absorbed also at a rotational speed level of $n > 7,000 \text{ 1/min.}$

[0021] The foregoing disclosure has been set forth merely to illustrate the invention and is not intended to be limiting. Since modifications of the disclosed embodiments incorporating the spirit and substance of the invention may occur

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to persons skilled in the art, the invention should be construed to include everything within the scope of the appended claims and equivalents thereof.